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Images Processing: A Mobile Augmented Reality Prototype for Vehicle Parking

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HIGHLIGHTS

- Car parking security issues tend to increase with the growing size of a city especially when the major centers of activity continue to grow in terms of size.
- Parking in public areas can be very tasking with little or no form of security because it is fraught with all sorts of hazards created by either drivers or lack of parking structures.
- Augmented Reality (AR) can be used to extract information from the textual car plate number to enhance security monitoring.
- AR helps the existence of information accessibility to a better position by communicating the history behind the textual document or image to trace the car's owner.

ABSTRACT

The emergence of augmented reality has made unstructured data processing an interesting field of study. Augmented reality enhances the retrieval of vital information from text and images. This research is centered on the development of a prototype using augmented reality to reduce the problem of security issues inherent in the context that bothers cars parked. The prototype was based on an AR application that runs on a smartphone. It reads through the car plate number which immediately matches with the car information on the central database of the Federal Road Safety Corps. The AR-Information device displays the car owners' information on the reader's mobile screen. The prototype was implemented and the interview was carried out among 59 staff of Al-Hikmah University in Nigeria. The respondents were to evaluate the usability of the AR-Image Processing prototype. 97.72% of respondents agreed that the proposed AR-Information device has demonstrated high usability in reducing the problem in security that was inherited in the car park and found it interesting.

Keywords: *Augmented reality, Car park, AR-Image Processing Prototype, Direct text, Car plate number.*

INTRODUCTION

With the rapid growth of computer and communication technologies, a demand for discovery finding of relevant information becomes high. Thus, most of the available information is accessed in direct text form. Usually, relevant information is presented in two different approaches; the structured and unstructured approaches. Structured information refers to direct information accessibility where data is stored in fixed fields within a record or file. This is in contrast with unstructured information where the data do not reside in fixed fields. As technology advances at an exponential rate, smartphones have become an indispensable tool for daily activities, including driving. With an ever-increasing number of vehicles on the road, accidents have become more frequent, leading to higher numbers of injuries and fatalities. Side road double parking and insecure parking areas are among the main causes of road accidents. To improve road traffic safety, a mobile Augmented Reality app for vehicle evaluation and safety has been developed. The app, which can be accessed via smartphones, incorporates several features that drivers can use to improve the safety of their vehicles. In addition to providing information about vehicle safety, the app also helps drivers locate their parked vehicles, especially in large and unfamiliar parking areas. The app includes other useful functions such as the storage of information regarding vehicle maintenance and legal documentation. The app reminds drivers when maintenance is due or when documents need to be renewed, contributing to safer and more efficient driving (Al Rajab, Loucif & Kousi, 2022).

Consequently, special techniques that can operate on textual data are needed to extract information from car plate numbers. Augmented Reality (AR) can be used to extract information from the textual car plate number. AR is a new emerging technology where computer-generated digital information is overlaid onto a live direct or indirect physical real-world environment, thus enhancing the user's perception of reality (Azuma, 1997; Zaibon, Pendit & AbuBakar, 2015). The history of AR technology dates back to 1968 when Ivan Sutherland at the University of Utah, developed the first Head-Mounted Display System. The system used computer-generated graphics to show users simple wireframe drawings and the first use of AR technologies for information retrieval was in the 1990s when applications were aimed to increase the training results of pilots (Caudell & Mizell, 1992).

AR helps the existence of information accessibility to a better position by communicating the history behind the textual document or image. In the case of a vehicle, the identification is towards registration and engine number. That is why it needs technology that helps to match all about the vehicle and owners' information and share it with the world. This becomes the role of AR to divulge information about the vehicle owner on the motion or during parking. Since information is the legacy of a nation that needs to be conserved as well as the reflection of the vehicle's history that needs to be learned for the future. Hence, vehicle identification has four ways; category of the vehicle, registration number, the colour, and the owner's information (Ozbay & Ercelebi, 2005). While owner details are important to be preserved for security purposes. Hence this paper presents ongoing research work that developed a prototype system that can extract important information about vehicles' owners through registered plate numbers by using Augmented Reality.

LITERATURE REVIEW

Most of the information is stored and represented in an unstructured manner, which is in textual documents or images. To extract the important information from the textual, an information extraction is required. However, AR techniques are needed to analyse the text or image before any information extraction can be

done. The understanding of what and how the information is extracted from unstructured data is discussed with some related research works in AR and information processes.

Augmented Reality

The term augmented reality (AR) was coined in 1992 by Boeing researcher Thomas Preston Caudell, who developed an AR application for industrial use to view some assembly diagrams. Today, there are several definitions of AR, although the most shared is that provided by Paul Milgram (Department of Industrial Engineering, University of Toronto) and Fumio Kishino (Department of Electronics, Information Systems, and Energy Engineering, Osaka University). They theorize the existence of different types of reality that create a continuum, which, starting from the real world, leads to a completely virtual world (Arena, Collotta & Pau, 2022). AR's basic functionality consists of creating links, direct or triggered by user interaction with the device, between the real world and the information generated by a device or electronic information. This circumstance provides an interface to the user of an electronically enhanced physical world. AR is the technology that aims to digitally integrate and expand the physical environment or the user's world, in real time, by adding layers of digital information. This integration can be applied to various display technologies capable of overlaying or combining information (numbers, letters, symbols, audio, video, graphics) with the user's view of the real world. (Arena, Collotta & Pau, 2022).

Augmented reality (AR) is a current emerging technology nowadays. Its breakthrough has made many changes in various fields in terms of technological aspects. AR technology does not replace the whole environment but rather adds certain virtual objects into the real world (Azuma, 1997). AR overlays the virtual object in real-time and the same space as mobile technology. In addition, it enables access to users on mobile phones Chen, Tsai, Vedantham, Grzeszczuk & Girod, 2009; Vlahakis, el at., 2001; Choudary, Charvillat, Grigoras & Gudjos, 2009; Qiu, el at., 2017). Since 1997, mobile AR has been implemented rapidly in many fields, such as information accessibility, security, education, entertainment, tourism, architecture, navigation and pathfinding, and geographical fieldwork (Kounavis, Kasimati & Zamani, 2012). Woodcock (2016) came up with an Augmented Vehicular Reality (AVR) for autonomous vehicles and Advanced Driving Assistance Systems to enable the vehicles to detect, communicate, and share visual information with vehicles around, to achieve this, the authors made use of three-dimensional (3-D) views.

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Image Processing technology

As science and technology continue to advance, the performance of mobile terminal hardware has greatly improved, and smartphones have become widely popularized, leading to new experiences and methods in image processing techniques. This study focuses on the application of processing technology based on mobile augmented reality techniques for vehicle evaluation and safety. Initially, The collection of unstructured data from car owners is essential for parking and identification purposes. This data is then processed through augmented reality techniques to identify, design, and develop a mobile application that provides ease of use for car owners, security personnel, and car evaluation purposes. By leveraging

augmented reality, the collected data is transformed into useful information that helps identify and differentiate between cars and their respective owners. The resulting mobile application allows for an efficient and convenient parking experience, with enhanced security features to ensure the safety of the parked cars. The evaluation of the parked car for security purposes is also streamlined through this process, allowing for accurate and efficient assessments. Overall, the use of augmented reality in the processing of unstructured data from car owners has significant benefits, including improved parking experiences and enhanced security measures. (Lu, Zhao, & Xu 2023).

Vehicle Identification Number

The use of vehicles as a means of traveling by road is a large growing transportation system in Nigeria and other countries; hence Vehicle Information System deals with maintenance of records of each vehicle owner. It also includes maintenance of information like schedule and details of each vehicle (Feiner, MacIntyre, Höllerer & Webster, 1997). Also, the researcher gets to know that there are many operations, which they have to do manually. It takes a lot of time and causes many errors.

Due to the challenges faced by people with parking spaces, a smart vehicle parking system was designed using genetic algorithm techniques to elevate the stress and challenges of parking cars at shopping malls (Thomas & Kovoor, 2018). This genetic algorithm approach for the parking space helped to some extent in alleviating the challenges of scarcity in parking space. Vehicle tracking is all about gathering information about the vehicle and the activities of a company or owner. Most companies use this to help organize information regarding their customers, which can be provided at the time of request. When this information is organized, customer services can be performed better and errors can be minimized. It takes more than careful accounting to have an effective vehicle tracking system in the car park.

Car Park uses have several unique features that distinguish them from other structure uses. A lack of understanding and recognition of these distinct characteristics by users and those responsible for maintenance is believed to be the major cause of many of the common problems identified in these parks (Carl and Timothy, 2006). Parking is generally classified as either “static” or “automated.” Automated parking is more common in Europe, while static parking is the most prevalent type of parking in the United States (ike, Jolly, Pundsack, Stewart, & Whapples, 2011). The two types of ramps that can be used are straight ramps and curve ramps (Boggs, Hezaveh & Cherry, 2019). The selection of the line space will be determined by the overall size of the car park, the shape of the site, and the use for which the car park is intended. Starting from the planning dimensions, you consider the bay width, aisle width, ramp dimensions, planning grid, alignment paths to exit barriers, means of escape distances from the car to the destination, security, visibility, space allowances, and payment system among other things. However, the following guidelines are not complied with by the users. Consequently, security challenges arise (Hart, 2015).

METHODOLOGY

The development of the prototype system in this research was based on the development cycle of the information extraction process with the AR techniques. This system has been developed to assist security or readers of vehicle plate numbers to get important information about the vehicle’s owner from the mobile application without wasting their time using AR techniques. To develop a successful prototype system, a development cycle methodology is adopted, which consists of three phases; problem identification, system design, and system development. Each phase is explained in the next section.

Problem Identification

This phase is important in the development of the system because it will provide an opportunity to develop the system with fully functional features and meet user requirements. In this research, the problem that has been identified is the packing issue and the required security to identify the cars' owner through extracting information from unstructured data in car plate numbers which is time-consuming. It has been observed that sometimes cars are packed to block other cars due to limited space. Also, for security purposes, it has been proved difficult to identify the cars' owners in case of emergency needs. Thus, manual recording might make a mistake by missing the relevant information while recording, and this process requires more time. Therefore, it would be useful if a security or reader could use a system to extract important information about the car owner from the vehicle plate number, such as the name of the vehicle owner, the owner's mobile number, the address, the vehicle model, the manufactured year, and the vehicle colour. Therefore, the most suitable solution to this problem is to develop a system that can extract the owners' information from the textual document (plate number) automatically, faster, and effectively.

System Design

To overcome the aforementioned problem in the previous phase, a system that can extract the required information is suggested. The Mobile Augmented Reality (MAR) technique has been selected to be implemented in the system. The focus is on information processing. Following in the system design of the system for information extraction from vehicle plate number. Figure 1 shows the system architecture design for the prototype. From Figure 1, there are three basic components in the system architecture design of the prototyping system that need to be developed. They are Input, Augmented Reality (Text Analyzer and Information Process), and System Output. Each of the components is explained as follows:

- Input: This comprises of User, Process, and Textual Document. A user will provide input to the system and the input must be a textual document of the vehicle plate number, which could be numerical, text, or images. The input process is a snapshot approach; this allows capturing the unstructured data.
- Augmented Reality: This component is the main section that transforms the unstructured text into an information system. It comprises two components; a text analyzer and an information extractor. Mobile AR usually has a general section that is explained in Table 1. However, the text analyzer contains a syntactic parser and the parser determines the structure of each text or image captured by the camera. Figure 2 shows the parts that are needed for the text analysis process in AR.

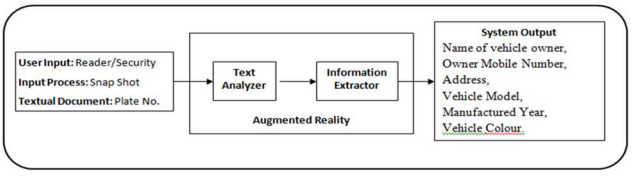

Figure1: System Architecture Design

Table 1: Parts of Mobile AR

Components	***Description***
Tracking	Many options. GPS, accelerometer, solid state compasses, wireless sensors, etc. need to be mechanical, magnetic sensing, GPS, ultrasonic, inertia, and optics. Includes: sensor-based tracking, vision-based tracking and hybrid-based tracking
Interaction & User Interfaces	Tangible interface, collaborative interface, hybrid interface, emerging multimodal interface

Tracking and Sensing	Important component. Required great input variety and high bandwidth, higher accuracy, and longer range.
Registration	Important component. Objects in virtual and real environments need to be aligned to make the illusion of the unity of the two worlds.

(Source: Zaibon, Pendit & AbuBakar, 2015).

The information extractor is the component that extracts vehicles' owner information by doing a matching process with the database provided by the Federal Vehicle Registration Services Database (FVRS) through the Internet service. In this research, the information extractor extracted the name of the vehicle owner, the owner's mobile number, the address, the vehicle model, the manufactured year, and the vehicle colour.

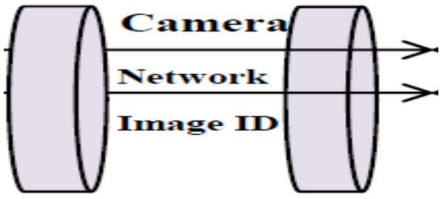

Figure 2: Parts for image analysis process in AR.

- The System Output: The system produces a result extracted from the database which consists of the name of the vehicle's owner, the owner's mobile number, the address, vehicle model, manufactured year, and vehicle colour. This result is presented in a tabular form.

System Development

In the development process of the prototype, the **IntView** methodology was adopted. This involves two steps, which are pre-production, and production (Haroon & Abdulrauf, 2015). Hence, the development of the prototype is conducted based on the following steps:

Step 1: Pre-production

In developing a prototype, it is important to involve users and experts before the development of the prototype begins. The development of a prototype takes up the challenge of ensuring opportunities for database accessibility to all vehicle registrations through the Federal Road Services Commission (FRSC). This reflects the user-centered design approach.

Step 2: Production

The major objective of this design is to allow the system to capture data related to vehicle owner profiles to match identified information, such as car owner information, car color, and car model records through unstructured data of the car plate number. Hence, it enhances car monitoring during driving and when packed. This constitutes various modules among which administrator and user modules are integral. User is granted access only through the username and passwords created from at first visit to the AR mobile application or when registering at the web portal, to utilize the features available to the vehicle information tracker from the park terminal. The administrator module is handled by an authorized administrator, to review user status.

The design is the drawing, planning, sketching, and arrangement of many separate elements in the design of the new system, the input specification, the database design, the processing specification, and the output specification as well as other files that are important in the mobile augmented vehicle information tracking system and its application to automated Unified Mobile vehicle information database system for easy usage and download.

The input specification involves the entire input requirement used by the application operator for registration. The data that will be entered into the system will be from the updating of vehicle owner profile records online; all from the database of the Federal Road Services Commission (FRSC). The output specification involves a Mobile Augmented Vehicle Information System that demands efficient design of the output and uses of the Graphical User Interface (GUI). This design is obtained from the mobile system. Figures 3 and 4 show some interfaces of the login section that comprises of login form, username and password, and features of the application system.

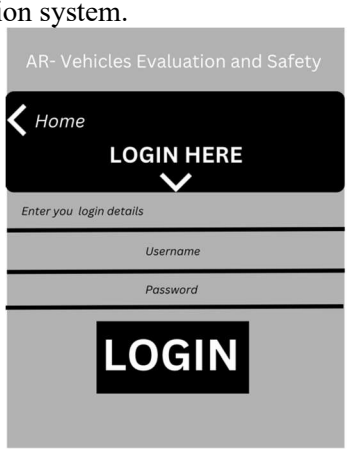

Figure 3. Login page

Figure 4 interface shows the application section that comprises user records and documents.

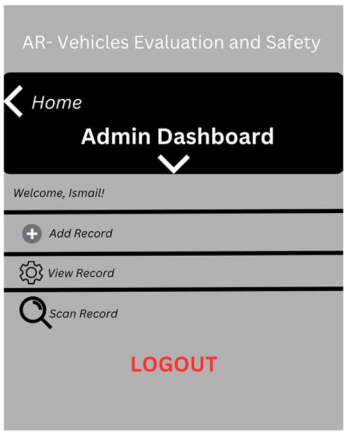

Figure 4. Administration Page

Figure 5 shows the profile of the registered users' information.

Figure 5: Information Profile page

Figure 6 displays the verification interface that matches the information on the vehicle plate number with the aid of an Augmented Reality Mobile System with a database. It scanned the unstructured data of plate numbers.

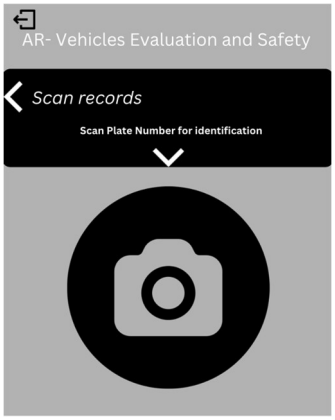

Figure 6: Scan Vehicle Plate Number

EVALUATION

To clarify the effectiveness and efficiency of the designed prototype as expected, a series of practical use of AR-Information devices and unstructured interviews[1] has been carried out to gather data. The purpose of the interview is to determine the optimal effective usage of the proposed prototype and factors that are leading to or enhancing its usage, particularly, about seeking vehicles' owner information when it is needed. For that purpose, the interview was done in Al-hikmah University, Nigeria. As the data, fifty-nine (59) academic, and non-academic staff and visitors required information were gathered from 24th to 29th January 2021. Ten (10) questions were addressed to seek the perception of respondents on issues such as respondents' understanding of AR usage, factors leading to car park issues, motivation towards the AR-

[1] The unstructured interview is a non-standardized interview type. It allows the researcher to examine the respondent for more detailed responses where clarification is needed. This type of interview is concerned with the meanings that respondents ascribed to a phenomenon. According to Arksey and Knight (1999), interviewing is an energetic approach of supporting people to make unambiguous things that have hitherto been detailed to articulate their tacit perceptions, understandings and feelings.

Information prototype usage, and the effectiveness of the developed AR-Information prototype for information accessibility.

Almost every involved staff was happy and owners of a mobile phone (including visitors) that was used for the experiment. "The Car Owner's AR-Information Assistant" is a mobile application for the Smartphone. The plate number of the cars is supplemented with an image from the screen of the Smartphone, which enables a lot of remarkable information derived. A radical methodological solution to the parking and security problem is that the staff uses an AR- mobile application, to acquire the complete cars' owner's information. Directly displayed in the reader mobile through the augmented reality (AR) mode, the procedural manager (subtitles, the plate number with car owners' information through the available online database for FRSC). The AR-Information device sends the car owners' information to the reader or security mobile screen. It is important to note that the research methodology enables to use of all traditional security tools. New forms of information accessibility arise from old ones.

Result

Response about AR-Information Prototype for Car Owners' Information

It is interesting to know the staff's (respondents) opinions about AR technologies in the information process. In this version of the pilot experiment, the staff (with the AR-Information Cars' owner Prototype) has access to the cars' owner information based on their need. Then after the experiment they were interviewed to answer some questions: "What do you feel about the AR-Information Prototype used?" Table 2 illustrates the results of interviewing of staff and visitors.

Table 2: Results of interviewing of staff and visitors

Answers of Participants (staff and visitors)	Number Participants		
	Agreed	**Not Agreed**	**Total**
That was exciting and I will install it on my Smartphone, I am interested in it.	59 (100 %)	0	59
It is good for monitoring the security threat.	59(100 %)	0	59
It enhances the car owners' information accessibility.	59(100 %)	0	59
It is unusual, but I do prefer text messages, I do not own a Smartphone.	17 (10%)	42 (90 %)	59
I do not care; that does not matter; there are no differences in manual recording	2 (1.18 %)	57 (98.82 %)	59

Furthermore, Table 2 shows the summary of the level of agreement in supporting AR implementation for this study. This is done to evaluate the proposed system architecture, which is transformed into a working prototype. It exhibits that the mobile AR approach with vehicle information system gives a faster searching approach.

CONCLUSIONS

At this stage, there are many promising models of the AR interaction. We deal with a new group of information technologies. They are still an innovational phenomenon in information mining. The AR-Mining area progresses very rapidly: much faster than the searching technique, the results have already been achieved. The psychological and innovative aspects of the AR-Information Cars' owner Prototype usage are of universal significance.

CONFLICT OF INTEREST DISCLOSURE

The authors declared that they have no conflicts of interest to disclose.

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